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Space: The Cluttered Frontier

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SPACE: THE CLUTTERED FRONTIER

CHRISTOPHER D. WILLIAMS

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I. INTRODUCTION

SINCE THE LAUNCH of the first artificial satellite in 1957, outer space has held a great deal of promise for mankind. From new medicines to bold scientific discoveries, the possibilities seemed limitless. Recently, however, the promise of space has become a large question mark. This change in attitude is largely due to fears associated with orbital space debris.

While the orbital debris population has not grown large enough to prevent the exploration of outer space, some fear that, if the situation remains unchecked, mankind will no longer be free to venture into orbit.¹ Even if the situation does not deteriorate to that point, the current debris population is large enough to cause serious operational problems to various missions. For example, since the inception of the U.S. space shuttle program, National Aeronautic and Space Administration officials have had to replace at least twenty-seven windows on various orbiters due to dam-

¹ *The Big 'Landfill' In the Sky*, CHRISTIAN SCI. MONITOR, Oct. 31, 1990, at 20.

age caused by minute debris particles.² In addition, different shuttle missions have been forced to alter their courses, sometimes quite dramatically, to avoid collisions with larger space debris objects.³

This Comment addresses several important aspects of the problem of space debris. First, it provides an overview of the space debris problem, including the origins of debris and the specific risks associated with space debris. Second, the Comment examines current international law provisions governing space debris, followed by a survey of individual countries' policies regarding debris. Finally, it explores some of the proposed solutions and provides a recommendation.

II. OVERVIEW OF THE PROBLEM

A. AMOUNT OF DEBRIS

At first glance, space debris would appear to pose little or no danger to missions in orbit. After all, outer space is a large area, and the objects mankind has launched are small in comparison. As is often the case, however, appearances can be deceiving. Space debris poses a very serious threat to human activities in outer space.⁴ Although mankind only ventured into outer space thirty years ago, we have launched approximately 18,000 objects into space since that time.⁵ While not all of these objects have remained in orbit, there are currently approximately 7100 objects in orbit capable of being tracked from Earth.⁶ Trackable objects, however, are not the greatest hazard because they often can be avoided by utilizing the maneuvering capabilities of satellites. Untrackable objects represent the most serious threat to space activities. Estimates of the current

² Miles O'Brien, *Space Debris Tests Run to Find Impact on Space Gear*, C.N.N. SCI. & TECH. WEEK, Jan. 9, 1993, at Transcript #149-1.

³ *Endeavor Mission Boosts Spacelab*, FLIGHT INT'L, July 7, 1993, at 19.

⁴ HOWARD A. BAKER, *SPACE DEBRIS: LEGAL AND POLICY IMPLICATIONS* 1 (1989).

⁵ James P. Lampertius, *The Need for an Effective Liability Regime for Damage Caused by Debris in Outer Space*, 13 MICH. J. INT'L L. 447, 449 (1992).

⁶ *Id.* Trackable objects include those with a diameter of at least 20 centimeters. *Id.* Smaller objects are not within the visibility limits of current radar. *Id.*

untrackable debris population range up to 3,500,000 objects.⁷ An additional danger posed by space debris is the more than forty-eight active or inactive satellites which carry over a ton of highly radioactive material in orbit around the planet.⁸

B. TYPES OF DEBRIS

The obvious question is: where did all of this space junk come from? The common perception is that space debris is merely a collection of old satellites in orbit. This, however, is not the case. Generally, space debris falls into four identifiable categories, which include inactive payloads, operational debris, fragmentation debris, and microparticulate matter.⁹ Inactive satellites represent twenty-three percent of the debris being tracked; burned out rocket stages represent ten percent; fragments constitute sixty-two percent; and active satellites make up the remaining five percent of trackable objects.¹⁰

Inactive payloads include formerly active satellites no longer controlled by their operators.¹¹ This category encompasses more than 1000 satellites or payloads in orbit at various altitudes around the Earth.¹² In addition, this category represents a long-term threat to orbital activities because these satellites have an orbital lifetime of several hundred years.¹³

⁷ Vladimir Kopal, *The Need for International Law Protection of Outer Space Environment Against Pollution of Any Kind, Particularly Against Space Debris*, PROC. 32D COLLOQUIUM L. OUTER SPACE 107, 116 n.2 (1989) (citing INTERAGENCY GROUP (SPACE) REPORT ON ORBITAL DEBRIS 1 (Feb. 1989) [hereinafter INTERAGENCY REPORT]). This estimate includes mostly very small fragments between 0.1 cm and 1 cm in size and approximately 17,500 fragments larger than a pea and smaller than a baseball. INTERAGENCY REPORT, *supra*, at 4.

⁸ NICHOLAS L. JOHNSON & DARREN S. MCKNIGHT, *ARTIFICIAL SPACE DEBRIS* 90-91 (1987).

⁹ BAKER, *supra* note 4, at 3.

¹⁰ Kopal, *supra* note 7, at 110.

¹¹ BAKER, *supra* note 4, at 4.

¹² *Id.*

¹³ Malcolm G. Wolfe, *Orbital Debris—Current Issues as They Impact on an Expanding Manned Presence in Space*, PROC. 28TH COLLOQUIUM L. OUTER SPACE 260, 261-63 (1985). The orbital lifetime of an object is determined by its orbital period, which is

Operational debris is closely associated with inactive payloads. This category includes objects used in various space activities that, for a variety of reasons, remain in orbit.¹⁴ Although the launch of space vehicles produces most of the operational debris (such as rocket stages, motors, or nose cones), mankind has left behind a variety of material.¹⁵

Fragmentation debris is by far the largest source of man-made space debris.¹⁶ This type of debris is a product of explosions, collisions, or other accidents.¹⁷ Explosions can be either deliberate or accidental, with most deliberate explosions resulting from military tests and most accidental ones stemming from propulsion failures.¹⁸ Collision debris is very problematic because it is produced in larger quantities, travels at greater speeds, and is generally too small to be tracked.¹⁹

The final category of debris is microparticulate matter. As the name suggests, these are very minute particles deposited in orbit by various means. The sources of microparticulate matter include solid-propellant rocket motors, coatings and materials of spacecraft (such as paint or binding agents), and miscellaneous other sources.²⁰

how long it takes to complete one circuit around the Earth. *Id.* Objects with longer orbital periods will remain in space for much greater periods of time and thus pose a long-term threat. *Id.*

¹⁴ BAKER, *supra* note 4, at 4.

¹⁵ *Id.* Other examples of operational debris include orbital transfer vehicles, restraining bolts, straps, clamps, staging mechanisms, fuel tanks, window covers, screws, gloves, dirty clothes, food wrappers, and frozen sewage. *Id.*

¹⁶ Captain Bruce L. McDermott, *Outer Space: The Latest Polluted Frontier*, 36 A.F. L. REV. 143, 145 (1992). One hundred identified satellite breakups are responsible for 49% of all catalogued objects in orbit. BAKER, *supra* note 4, at 5.

¹⁷ BAKER, *supra* note 4, at 4.

¹⁸ *Id.* at 5. Anti-satellite tests of the United States and the former Soviet Union contributed to the problem of space debris, as did deliberate destructions of satellites to prevent uncontrolled re-entry or recovery by a competing state. *Id.* See also JOHNSON & MCKNIGHT, *supra* note 8, at 13 (stating that 34 satellite breakups had been the result of intentional acts as of 1986). A typical explosion generates 200 detectable pieces of debris and possibly 1000 undetectable ones. McDermott, *supra* note 16, at 144 n.5.

¹⁹ BAKER, *supra* note 4, at 7.

²⁰ *Id.* at 8-9. Estimates of the amount of microparticulate matter range from 10 billion to thousands of trillions of parts. *Id.* at 8.

C. RISKS OF SPACE DEBRIS

1. *Damage Caused By Space Debris*

Numerous factors beyond the type of debris are relevant to assessing the potential harmful effects of debris.²¹ The primary reason debris poses any risk at all, however, is the fact that objects in orbit travel at incredibly high speeds. While individual velocities vary, orbital debris usually travels almost ten times faster than a rifle bullet.²² When objects are travelling at that velocity, small size does not translate into minimal damage. In fact "[a] 3 mm piece of space debris travelling at 10 km/sec. has as much kinetic energy as a 12 lb bowling ball travelling at 60 mph."²³ Given the relatively fragile construction of most orbital objects, the potential for damage is considerable.

2. *Probability of Collisions With Space Debris*

While the speed of objects is relevant to the amount of damage the objects might cause, the size of the debris is an important factor in determining the probability of collision with another space object because of the sheer number of objects in orbit. Obviously, the larger objects have the potential to cause much greater damage.²⁴ Even eight years ago, experts estimated that the collision frequency was between 0.24 and 1 collision per year, with the first significant collision predicted to occur sometime between 1989 and 2005.²⁵

Another factor impacting the probability and nature of collisions is the altitude at which objects orbit. Low Earth

²¹ These include the size of the objects in orbit, the altitudes at which they travel, their speeds, and the lengths of time the objects are in orbit. Gunnar Leinberg, *Orbital Space Debris*, 4 J.L. & TECH. 93, 98 (1989).

²² Philip J. Hiltz & Boyce Rensberger, *Science Notebook—Cleaning Up Space*, WASH. POST, Sept. 26, 1988, at A1.

²³ Leinberg, *supra* note 21, at 98.

²⁴ See BAKER, *supra* note 4, at 10 tbl. 1 (comparing size of debris, nature of threat posed, and probability of threat occurring).

²⁵ F. Kenneth Schwetje, *Current U.S. Initiatives to Control Space Debris*, PROC. 30TH COLLOQUIUM L. OUTER SPACE 163, 164 (1987). This estimate was based only on the tracked debris population and did not include untrackable debris.

Orbit (LEO), which stretches from approximately 200 km to 4000 km above the Earth, offers some of the best opportunities for scientific, commercial, and public uses, yet debris already crowds this area.²⁶ Because manned missions, including the proposed space station, use this orbit, the chance of collisions with debris is a serious hazard.²⁷

Geostationary Orbit (GEO) is also a very important orbit threatened by space debris. GEO is a geosynchronous orbit that allows objects to maintain an essentially stationary orbit over a particular area of the planet and, therefore, allows ground based tracking systems to remain in continuous contact without constant realignment. GEO is a limited resource of vital importance because only a limited number of orbital slots are available. All of the civil telecommunication satellites are in GEO, along with many meteorological, broadcasting, data relay, tracking, and remote sensing satellites.²⁸ The primary problems with debris generation in GEO are the limited number of available slots and the fact that, in GEO, objects that are not removed can have orbital lifetimes nearing ten million years.²⁹ Geosynchronous Transfer Orbit (GTO) is used primarily for objects passing into GEO from LEO. Because the orbital pattern is not uniform, objects left behind in GTO can have lifetimes ranging from a few months to many years.³⁰

One of the most serious dangers posed by debris, and also one of the greatest theoretical dangers, is the "cascade effect."³¹ The cascade effect is "a process by which space

²⁶ See BAKER, *supra* note 4, at 23. Activities currently occurring in LEO include research, telecommunications satellites, storage orbits, and manned activities, including space stations. *Id.*

²⁷ See Barbara Wood-Kaczmar, *Junkyard in the Sky*, NEW SCIENTIST, Oct. 13, 1986, at 38 (discussing the space station *Freedom* and the potential for life threatening encounters with space debris); see also Leinberg, *supra* note 21, at 99 (estimating that during the 17 year lifetime of the proposed space station, there is a 50% chance of it being struck by debris and a 1% chance of it being destroyed).

²⁸ Baker, *supra* note 4, at 25.

²⁹ *Id.* at 26.

³⁰ *Id.* at 24.

³¹ McDermott, *supra* note 16, at 146; BAKER, *supra* note 4, at 13. The cascade effect is also sometimes known as the "Kessler Syndrome." William B. Wirin, *Space Debris 1989*, PROC. 32D COLLOQUIUM L. OUTER SPACE 184, 189 (1989).

debris will become self-generating and therefore uncontrollable."³² The more space objects there are in orbit, the greater the probability that there will be a collision. With each new collision, there is a corresponding increase in the amount of debris, which would then result in an even greater probability of collisions.³³ Some experts state that, even if mankind launched no new objects into orbit, the debris population would continue to increase exponentially and make at least parts of Earth orbit, such as LEO, unusable.³⁴ While this is still a largely theoretical problem, simulations demonstrate the population of large space objects needed to begin such a chain-reaction is only two to three times the current number of objects in orbit.³⁵

3. *Interference Caused by Space Debris*

Another reason why the debris population concerns many experts is the effect it may have on scientific, commercial,³⁶ and military activities.³⁷ Some scientists fear space debris may impair the accuracy of scientific data received from transmissions distorted by debris interference.³⁸ Another problem with debris is that very small debris particles can cause the "graceful degradation" of solar panels and optical instruments on space objects.³⁹ In addition, debris can impact scientific activities without ever colliding with another object. Sometimes, debris reflects

³² BAKER, *supra* note 4, at 13.

³³ McDermott, *supra* note 16, at 146.

³⁴ BAKER, *supra* note 4, at 13.

³⁵ D. Felske, *The Space Debris Issue: Problems and Recommendations*, PROC. 33D COLLOQUIUM L. OUTER SPACE 417 (1990).

³⁶ The primary concern for commercial activities is the congestion caused in GEO by the abandonment of satellites at the end of their useful lives without boosting them to a disposal orbit. BAKER, *supra* note 4, at 18.

³⁷ *Id.* at 16-17; McDermott, *supra* note 16, at 146.

³⁸ McDermott, *supra* note 16, at 146. This same effect could also interfere with commercial satellite communications. *Id.*

³⁹ BAKER, *supra* note 4, at 16. Graceful degradation refers to the surface erosion of these objects which can spoil the accuracy of data collected.

light that either ground or space-based astronomical observers later interpret to be something it is not.⁴⁰

III. DEFINING SPACE DEBRIS

A. WHAT IS A SPACE OBJECT?

One of the most frustrating difficulties associated with the problem of space debris is that there is no agreement on how to define space debris or what to include within the scope of a legal definition. Although there are several international treaties dealing with the law of outer space, none of them define or describe what is commonly known as space debris.⁴¹ The treaties do, however, use the term "space object."⁴²

The definition of space object is key to analyzing the space debris problem. If the definition of space object includes space debris, then some international treaty provisions may apply. If, however, the term space object does not encompass space debris, parties must look to other sources for a remedy. Unfortunately, the term space object does not provide much insight into the space debris problem. The term has no clear definition, thus making it extremely difficult to determine precisely what debris is and when something gains that status.⁴³ The fact that the defi-

⁴⁰ Wirin, *supra* note 31, at 190. For example, what were thought to be pulsars turned out to be reflections from dead satellites' solar panels. BAKER, *supra* note 4, at 17.

⁴¹ BAKER, *supra* note 4, at 61.

⁴² "Space object" is defined to include the "component parts of a space object as well as its launch vehicle and parts thereof." Convention on International Liability for Damage Caused by Space Objects, *opened for signature* Mar. 29, 1972, art. I(d), 24 U.S.T. 2389 [hereinafter Liability Convention]; *see also* Convention on Registration of Objects Launched into Outer Space, *opened for signature* Jan. 14, 1975, art. I(b), 28 U.S.T. 695 [hereinafter Registration Convention] (using the same language as the Liability Convention to define "space object"). The definitions included in these conventions appear to satisfy only the specific needs arising from the treaties. Vladimir Kopal, *Issues Involved in Defining Outer Space, Space Object and Space Debris*, PROC. 34TH COLLOQUIUM L. OUTER SPACE, 38, 40 (1991).

⁴³ I.H. Ph. Diederiks-Verschoor, *The Increasing Problems of Space Debris and Their Legal Solutions*, PROC. 32D COLLOQUIUM L. OUTER SPACE 77, 77 (1989). The drafters of the Liability and Registration Conventions never specifically addressed whether space debris was included under the term space object. BAKER, *supra* note 4, at 63.

nition of space object includes the term 'space object' reveals how circular the analysis in this area can become.

There are a few types of objects which clearly fall within the meaning of space object. These include active satellites and spacecraft.⁴⁴ It is unclear, however, whether inactive satellites or spacecraft are within the scope of the term space object. In addition, there is a great deal of debate about whether an object that does not originate on Earth or one that does not achieve orbit qualifies as a space object.⁴⁵ This issue could become an important one in the future when mankind begins assembling spacecraft in orbit.

Various commentators have proposed definitions of space object to try to solve some of these problems. Dr. Lukin, a Russian lawyer, defines "space object as an object belonging to one or more states or non-governmental entities, launched into outer space or on a celestial body for collecting and transmitting information, for transportation and manufacturing processes, and controlled by the ground center."⁴⁶ One Czechoslovakian professor would define space object to include all man-made instrumentalities launched into outer space and moving in orbits around the earth or on other trajectories.⁴⁷

Another possible approach to defining space object is the functional approach. This definition would define space object as any space instrument in its "operational state."⁴⁸ According to Baker, this definition would encompass space debris, although the argument is somewhat unconvincing. Baker's own proposal would define space object as any object intended for launch (whether or not into orbit or beyond), launched (whether or not into orbit or beyond), or assembled in space, and any instrumentality used as a

⁴⁴ BAKER, *supra* note 4, at 64.

⁴⁵ *Id.*

⁴⁶ William B. Wirin, *Space Debris and Space Objects*, PROC. 34TH COLLOQUIUM L. OUTER SPACE 45, 46 (1991).

⁴⁷ Kopal, *supra* note 42, at 40. This definition includes both launch vehicles and payloads. *Id.*

⁴⁸ BAKER, *supra* note 4, at 40. This definition includes both launch vehicles and payloads. *Id.*

means of delivering any object previously described. This definition would include any part of an object as described above and any object on board a space object which either intentionally or unintentionally becomes detached, ejected, emitted, launched, or thrown from the space object at any time.⁴⁹

B. WHAT IS SPACE DEBRIS?

Once the world community agrees on a definition of space object, it must develop a definition of space debris. As with the term space object, there is no consensus concerning the definition of space debris. In fact, many commentators have tried to avoid the term "debris" altogether.⁵⁰ Regardless of whether it is called debris, junk, or refuse, the scope of the problem remains the same. Therefore, because it is the most widely accepted term in the field, this Comment will continue to refer to the orbital objects as debris.

Space debris is most often referred to as a popular, rather than a legal, term⁵¹ used to describe components or fragments of space objects that are spent or no longer functional.⁵² Many consider space debris to be pieces of either launch vehicles or satellites (active or inactive) that remain in orbit and pose a threat to space activity.⁵³ However, because there is no universally accepted definition of space debris, the world community must develop one to satisfy the requirements of international space law.

⁴⁹ *Id.* at 67.

⁵⁰ See Ernst Fasan, *Space Debris—A Functional Approach*, PROC. 35TH COLLOQUIUM L. OUTER SPACE 281, 282 (1992) (discussing possible use of terms such as junk, pollutant, contaminant, flotsam, refuse, etc.); see also BAKER, *supra* note 4, at 61 (suggesting the term "space refuse"); Wirin, *supra* note 46, at 46 (suggesting the term "space contaminant"); Kunihiro Tatsuzawa, *The Protection of Space Environment: The Problem of Space Wreckages*, PROC. 32D COLLOQUIUM L. OUTER SPACE 173, 173 (1989) (suggesting the term "space wreckage" because it is a "legal one" and it may include scattered fragments as well as inactive or out of control satellites).

⁵¹ Fasan, *supra* note 50, at 282.

⁵² Kopal, *supra* note 42, at 41.

⁵³ Wirin, *supra* note 46, at 45.

Fasan would define space debris as "all artificial objects which move in Outer Space due to the natural laws of motion and which are not under control, thus except active satellites."⁵⁴ Another approach would be to define space debris as "a no longer functioning, no longer controlled, nonuseful or abandoned space object or part of such."⁵⁵ A completely different way of defining debris would be to list the types of objects which would be considered debris, such as used rocket stages and separation devices.⁵⁶ A laundry list approach, however, is limiting because new contingencies invariably arise which were not considered when drafting the original list. Instead of continually redefining the list, the world community should develop a definition that provides the flexibility to deal with new situations. The same rationale applies to proposed definitions focusing on the division of the term space object into several defined categories.⁵⁷

It may be easier to identify what is *not* space debris than to agree on what is space debris.⁵⁸ Under this approach, a functioning space object and its component parts would clearly not be space debris if it were in its predetermined orbit and remained under control.⁵⁹ The European Space Agency, in its report on space debris, apparently took this approach by dividing man-made space objects into two categories: 1) active satellites and spacecraft that were under control; and 2) space debris that comprises all other ob-

⁵⁴ Fasan, *supra* note 50, at 282.

⁵⁵ Stephen Gorove, *Space Debris in International Legal Perspective*, PROC. 32D COLLOQUIUM L. OUTER SPACE, 97, 97 (1989). This approach is similar to the approach used by many international organizations which consider a space object to be debris when it has used all of its fuel and can no longer be controlled. Leinberg, *supra* note 21, at 101.

⁵⁶ Oscar Fernández-Brital, *Space Debris A Form of Appropriation of Outer Space*, PROC. 34TH COLLOQUIUM L. OUTER SPACE 164, 165 (1991) (discussing various proposed definitions of space debris).

⁵⁷ See Kopal, *supra* note 42, at 41 (discussing the possibility of splitting the term "space object" into categories of space station, space object in a narrower sense, and space debris).

⁵⁸ *Id.* at 42 (quoting Professor C.Q. Christol).

⁵⁹ *Id.*

jects, such as deactivated satellites, rocket stages, fragments, particles, etc.⁶⁰

A good definition of space debris should be able to address the needs of current and future space operations and must not create obstacles to the growth of activities in outer space.⁶¹ In the vast majority of definitions proposed by commentators, the common factor has been control over the object in question. By focusing on control, one can avoid many of the problems associated with differences in the sizes of objects, their composition, and their origins. Stephen Gorove's proposed definition is a good example of the control approach, as is the approach taken by the European Space Agency.⁶² Control, however, should not be the sole criterion to judge whether an object is or is not debris. It is easy to imagine objects that are not under the continued control of any entity yet still serve useful purposes. For example, a temporarily malfunctioning satellite might be out of control for a period of time, but it should not be considered debris if it could be repaired. Because of these factors, a definition based on Gorove's proposal could satisfy the requirement of encompassing all relevant objects while also providing some limits.

IV. INTERNATIONAL LAW PROVISIONS

A. OUTER SPACE TREATY

Various international treaties have provisions that might have ramifications for the problem of space debris. For the most part, however, relevant international law only provides general guidelines concerning behavior and does not offer specific rules or standards regarding the production of space debris. The first general treaty dealing with the law of outer space was the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer

⁶⁰ Wirin, *supra* note 46, at 46.

⁶¹ Kopal, *supra* note 42, at 39.

⁶² See *supra* notes 54, 55 and accompanying text (discussing definition based on the continued control or functioning of the object).

Space, Including the Moon and Other Celestial Bodies.⁶³ There are several statements in this treaty which arguably apply to space debris, but the arguments are often tenuous at best.

1. *Article I—General Principles*

The first three articles of the treaty discuss, in very general terms, activities in outer space. Article I states that the exploration and use of outer space "shall be carried out for the benefit and in the interests of all countries . . . and shall be the province of all mankind."⁶⁴ It can be argued that the accumulation of debris in orbit is not in the interest of all countries and that this provision therefore should prohibit the pollution of outer space by debris.⁶⁵ Dr. Fernández-Brital suggests that the treaty's contemplated use is an intelligent and beneficial use; leaving debris in outer space is, accordingly, not an authorized use.⁶⁶ However, no commentator has seriously suggested that this provision provides a solution to the debris problem. Instead, it merely demands generally responsible behavior from the users of outer space.⁶⁷

2. *Article II—Appropriation Theory*

Article II of the treaty allows for a more interesting argument. This article states, "[o]uter space . . . is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."⁶⁸ In a sense, space debris may constitute a form of appropriation of outer space. Because two objects cannot occupy the same space (orbit) at the same time, placing debris in space

⁶³ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, *opened for signature* Jan. 27, 1967, 18 U.S.T. 2410 [hereinafter *Outer Space Treaty*].

⁶⁴ *Id.* art. I.

⁶⁵ Leinberg, *supra* note 21, at 101.

⁶⁶ Fernández-Brital, *supra* note 56, at 166.

⁶⁷ Stephan Hobe, *Space Debris: A Proposal for its International Legal Regulation*, *PROC. 34TH COLLOQUIUM L. OUTER SPACE* 194, 195 (1991).

⁶⁸ *Outer Space Treaty*, *supra* note 63, art. II.

removes the possibility of another object using that location.⁶⁹

This approach is related to the view of outer space as a commons. Some argue that Articles I and II of the Outer Space Treaty provide a structure for use of outer space similar to a terrestrial commons, thus encouraging spacefaring nations to take maximum advantage of the resource of space in the shortest time possible.⁷⁰ As with a terrestrial commons, the use or consumption of the resource by one party necessarily precludes that use by another member of the commons.

Thus, the placement of debris in orbit may in fact constitute an appropriation. However, as in the case of accidental fragmentary debris, this appropriation may be entirely out of the control of any party. In addition, if the premise of the argument is valid, then any space object, not just space debris, would constitute an appropriation of outer space in violation of Article II. This clearly was not intended by the drafters of the treaty.

3. *Article VI and Article VII—Responsibility and Liability*

The next relevant provision of the Outer Space Treaty is Article VI, which states that party states shall bear international responsibility for national activities in outer space, regardless of whether or not those activities are conducted by government or private entities.⁷¹ Again, this provision of the treaty arguably applies to space debris because it results from states' activities in outer space. However, in terms of prevention of debris, as opposed to responsibility for debris, the provision is not adequate. It focuses only on responsibility for debris after its creation. The problem with this is that, first, it currently is virtually impossible to identify the

⁶⁹ Fernández-Brital, *supra* note 56, at 166. Dr. Fernández-Brital discusses how, throughout history, the depositing of objects (such as flags) represented an acceptable form of national appropriation before any consistent occupation occurred. *Id.*

⁷⁰ Lawrence D. Roberts, *Addressing the Problem of Orbital Space Debris: Combining International Regulatory and Liability Regimes*, 15 B.C. INT'L & COMP. L. REV. 51, 55 (1992).

⁷¹ Outer Space Treaty, *supra* note 63, art. VI.

source of any particular piece of debris and second, even if the debris is identifiable, the party could only be held responsible for damages because removal operations are not technologically or economically feasible at this time.⁷²

Article VII of the Outer Space Treaty deals more specifically with liability of a state for damage to another state, which is a party to the treaty, from the other state's space object or its components.⁷³ While this might serve to deter some states from producing debris, the provision obviously does not prohibit the creation of space debris. The same problems with identification and enforcement that limit the value of Article VI also render Article VII realistically ineffectual.

4. *Article VIII—Ownership and Jurisdiction*

Article VIII of the Outer Space Treaty is not pertinent to the creation of debris, but it does have implications for the removal of debris. This provision states: "A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body."⁷⁴ States interested in removing debris in the future must overcome the jurisdictional problems created if debris is included within the scope of the term "object."⁷⁵ This provision, however, has not been closely examined due to the overriding provisions of the Registration Convention.⁷⁶

5. *Article IX—Due Regard and Harmful Contamination*

Probably the most closely examined provision of the Outer Space Treaty, in terms of space debris, has been Arti-

⁷² Leinberg, *supra* note 21, at 102; *see also* BAKER, *supra* note 4, at 74.

⁷³ Outer Space Treaty, *supra* note 63, art. VII.

⁷⁴ *Id.* art. VIII.

⁷⁵ *See supra* notes 41-62 and accompanying text (discussing the definitions of space object and space debris).

⁷⁶ *See infra* notes 115-36 and accompanying text (discussing the Registration Convention).

cle IX.⁷⁷ In general, this article requires parties to the treaty to conduct their activities in space with "due regard" for the interests of other parties, to avoid "harmful contamination" of outer space, and to consult with other states if the activity could interfere with the activities of the other states.⁷⁸ The first sentence of Article IX requiring recognition of other states' interests could be applicable to space debris in the sense that the generation of space debris is not in another country's interest.⁷⁹ This argument, however, is very similar to that associated with Article I of the Outer Space Treaty, and experts do not afford it much credence because it does not provide concrete guidelines.⁸⁰

The most important provisions of Article IX are the prohibition on "harmful contamination" and the requirement of consultation if activities are believed to have the potential for "harmful interference" with space activities. As with most aspects of space debris, however, any possible effectiveness of these provisions is thwarted by problems with

⁷⁷ Outer Space Treaty, *supra* note 63, art. IX. Article IX reads as follows:

In the exploration and use of outer space . . . States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space . . . with due regard to the corresponding interests of all other States Parties to the Treaty. States Parties to the Treaty shall . . . avoid . . . harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space . . . would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space . . . it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space . . . would cause potentially harmful interference with activities in the peaceful exploration and use of outer space . . . may request consultation concerning the activity or experiment.

Id.

⁷⁸ *Id.*

⁷⁹ Leinberg, *supra* note 21, at 103.

⁸⁰ See *supra* text accompanying notes 64-67 (discussing art. I of the Outer Space Treaty); see also BAKER, *supra* note 4, at 96-97 (discussing limitations on "corresponding interests" language of art. IX of the Outer Space Treaty).

definitions.⁸¹ There is no generally accepted definition of either "harmful contamination" or "harmful interference," and the treaty does not provide any guidance.⁸² One commentator suggests that harmful contamination does not include space debris and refers only to astronauts and spacecraft.⁸³ Another argues that, from a strict reading of the treaty language, the prohibition on harmful contamination only extends to activities relating to the study or exploration of outer space and would not apply to commercial utilization of space.⁸⁴

It would appear that the original intention of the drafters of the Outer Space Treaty was not to protect directly the outer space environment.⁸⁵ By framing the article in the manner they did (i.e., by not providing a definition), the drafters allow a state to deny any contamination because the question of what is an appropriate action is completely within the discretion of the state.⁸⁶ The test for "harm" is whether the activity interferes with the future use of outer space, not whether the outer space environment is damaged.⁸⁷ Article IX provides "no direct protection of the outer space environment *per se*."⁸⁸

The final provision of Article IX deals with the duty of parties to the treaty to "undertake appropriate international consultations" before conducting any activity which may harmfully interfere with other nations' space activi-

⁸¹ See Wirin, *supra* note 46, at 47-48 (discussing various commentators' suggestions for defining harmful contamination).

⁸² Leinberg, *supra* note 21, at 103.

⁸³ Y.M. Kolossov, *Legal Aspects of Outer Space Environment Protection*, PROC. 23D COLLOQUIUM L. OUTER SPACE 103, 104 (1980).

⁸⁴ Roberts, *supra* note 70, at 56.

⁸⁵ Hobe, *supra* note 67, at 195.

⁸⁶ *Id.*

⁸⁷ BAKER, *supra* note 4, at 95. Baker discusses in depth what he terms the "sci-lab perception" which has pervaded man's exploration and use of outer space. This perception or attitude views protection of the outer space environment as useful only to the extent that it does not affect the interests of the various spacefaring nations. According to Baker, this perception has had a profound influence on the way the various treaty drafters have approached the problems of outer space law. *Id.* at 87-98; see also Roberts, *supra* note 70, at 56 (stating that the "primary objective . . . of art. IX is to maximize exploitation of the space environment").

⁸⁸ Hobe, *supra* note 67, at 195.

ties.⁸⁹ One of the primary problems with this provision is that, in the vast majority of situations, a state's planned activities do not include the generation of space debris sufficient to constitute harmful interference. The one significant exception to this rule is anti-satellite testing (ASAT), but this is no longer a serious concern due to agreements restricting anti-satellite testing.⁹⁰ The effectiveness of this clause is extremely limited because it does not provide a veto over any state's activities; rather, it simply requires "consultations."⁹¹

Given the provisions of all of the articles of the Outer Space Treaty, it is apparent that any prohibition on the generation of space debris could only be found in the spirit of the treaty and not in its text.

B. LIABILITY CONVENTION

The Convention on International Liability for Damage Caused by Space Objects⁹² (Liability Convention) was enacted in 1972, after the Outer Space Treaty, to elaborate on the principles articulated in Article VI of the Outer Space Treaty, dealing with international responsibility for activities in space. The impetus behind the development of the Liability Convention was concern about possible damage to property or people on Earth, not to objects or people in space, although the drafters addressed damage in space to a limited extent.⁹³ Thus, like the Outer Space Treaty, the Liability Convention only addresses the problem of space debris in an indirect manner and does not provide a solution to the situation.

Article I of the Liability Convention is a definition section covering the terms "damage" and "space object," which are the most important for the purpose of this analysis. As discussed previously, the term space object "includes compo-

⁸⁹ Outer Space Treaty, *supra* note 63, art. IX.

⁹⁰ Leinberg, *supra* note 21, at 103.

⁹¹ McDermott, *supra* note 16, at 150.

⁹² Liability Convention, *supra* note 42.

⁹³ BAKER, *supra* note 4, at 79.

nent parts of a space object as well as its launch vehicle and parts thereof."⁹⁴ The convention also defines damage as "loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations."⁹⁵

These two terms come into play in the two provisions of the convention articulating when liability occurs. Article II of the Liability Convention provides that a launching state will be responsible for damage on the Earth's surface or to aircraft in flight caused by its space object under a theory of absolute liability.⁹⁶ In contrast, if the damage is to a space object or to persons or property on board a space object anywhere other than on the surface of the Earth, then the launching state is only liable for that damage if it is at fault.⁹⁷

The creation of a fault-based liability standard in the convention leads to several problems in terms of responsibility for damage caused by space debris.⁹⁸ The most obvious problem is identification of the debris. Generally, "[i]t is difficult, if not impossible, to identify the owner of most space debris."⁹⁹ Only a small percentage of objects are even capable of being tracked and, of those, a large number are not attributable to any particular source.¹⁰⁰ In addition, it

⁹⁴ Liability Convention, *supra* note 42, art. I(d); see *supra* notes 41-62 (discussing problems associated with the definition of "space object").

⁹⁵ Liability Convention, *supra* note 42, art. I(a).

⁹⁶ *Id.* art. II.

⁹⁷ *Id.* art. III.

⁹⁸ For purposes of discussing the Liability Convention, this analysis will assume that space debris is included within the term space object because, if it were not, then the Liability Convention would have no application in situations involving damage caused by space debris. However, it should be noted that, when the Liability Convention was being negotiated, the focus was not on the issue of liability for space debris damage. Leinberg, *supra* note 21, at 104; McDermott, *supra* note 16, at 155. In fact the negotiators intentionally avoided the issue for fear that the treaty would never be completed. BAKER, *supra* note 4, at 79; Lampertius, *supra* note 5, at 454 (indicating that negotiations for the Liability Convention lasted nearly ten years).

⁹⁹ Leinberg, *supra* note 21, at 104.

¹⁰⁰ See *supra* notes 6-8 and accompanying text (discussing debris population and tracking capabilities). Trackable objects also do not present the greatest possibility of producing damage since they can be identified and usually avoided.

is often difficult to determine exactly what caused damage to a space object.¹⁰¹ For example, "the cause of almost half the satellite breakups cannot be discerned."¹⁰² Some may have been simple malfunctions while others may have been the result of debris generated by a particular state.

Problems with proof are not the only difficulties associated with Article III of the Liability Convention.¹⁰³ There is also a great deal of uncertainty about the meaning of "fault" within the convention. Just because two objects collide, one a piece of debris and one an active space object, it is not automatically the "fault" of the debris. In reality, it could be the fault of neither party. Fault, however, is not even defined in the Liability Convention, and it carries many different possible interpretations. Baker suggests fault may be either objective or subjective, although subjective fault is probably the applicable standard since objective fault would merely be a reiteration of state responsibility under international law.¹⁰⁴ Since international law is almost entirely consensual, the objective fault view would allow a state to do whatever it wanted unless there was a demonstrated limiting rule of international law.¹⁰⁵

This leads to the issue of the lack of a standard of care required to establish fault in general.¹⁰⁶ This lack of an articulated standard of care is particularly important because of the absence of customary international law dealing with

¹⁰¹ Hobe, *supra* note 67, at 197.

¹⁰² Lampertius, *supra* note 5, at 458.

¹⁰³ The Liability Convention also does not state whether the damage caused must have been reasonably foreseeable. Liability Convention, *supra* note 42.

¹⁰⁴ BAKER, *supra* note 4, at 84. Baker states that objective fault would be based on a pre-existing legal duty while subjective fault would be more like the law of negligence. *Id.*

¹⁰⁵ Robert F. Stamps, *Orbital Debris: An International Agreement is Needed*, PROC. 32D COLLOQUIUM L. OUTER SPACE 152, 154 (1989).

¹⁰⁶ "Fault liability presumes that a standard of care exists by which one can judge the reasonableness of the defendant's actions." Lampertius, *supra* note 5, at 456. "Unintentional conduct is considered to be faulty only when the conduct violates some standard of conduct." McDermott, *supra* note 16, at 155.

space in general and space debris in particular.¹⁰⁷ Without a defined standard of care, the Liability Convention is fundamentally flawed in terms of responsibility for space debris. A complaining state must prove that the defendant state owed it a legal duty, that the duty was breached, and that the breach was the proximate cause of damage.¹⁰⁸ In the great majority of cases which might arise concerning space debris, a complaining state would have an extraordinarily difficult time establishing any of these three elements.

Various commentators have proposed standards which would provide a manner in which to assign responsibility under a fault based system.¹⁰⁹ However, the better approach may be to forgo fault-based liability altogether and move towards a strict or absolute liability standard, such as that used in Article II of the Liability Convention. As with most situations where strict liability is appropriate, space activities could be considered "abnormally dangerous" or "ultrahazardous."¹¹⁰ Under strict liability, the state choosing to engage in the activity should bear the risk of injury or damage when no measures could prevent the damage.¹¹¹ Shifting the cost from the victim to the entity that caused the damage would force that entity to take those costs into account when considering whether, and how, to proceed with its space activity. Another argument in favor of applying a strict liability standard is that such an approach is use-

¹⁰⁷ See ENVIRONMENTAL ASPECTS OF ACTIVITIES IN OUTER SPACE 149-90 (Karl-Heinz Böckstiegel ed., 1990) (setting forth various commentators' views on customary international law and space activities, particularly the pollution of space).

¹⁰⁸ Stamps, *supra* note 105, at 154.

¹⁰⁹ For example, Baker suggests the following standard:

A launching State would be negligent if it (1) abandoned deliberately an active satellite where the technology existed to retrieve it; (2) failed to maintain the required spacing between satellites in GEO; (3) failed to place a potentially inactive satellite in a disposal orbit; (4) failed to mitigate the production of space refuse; or (5) refused to remove space refuse resulting from its space activities.

BAKER, *supra* note 4, at 84; see also Lampertius, *supra* note 5, at 464.

¹¹⁰ BAKER, *supra* note 4, at 85; Lampertius, *supra* note 5, at 462.

¹¹¹ BAKER, *supra* note 4, at 85; see also Lampertius, *supra* note 5, at 462 (quoting Baker as providing the best explanation of why absolute liability should apply).

ful in situations where fault cannot be established.¹¹² In addition to the difficulties with detection and identification of debris, it might be impossible to establish fault when two active space objects collide, resulting in potential claimant states bearing the losses individually.¹¹³ While strict liability may be an appropriate solution, spacefaring nations are not likely to adopt it due to opposition by some of the major parties involved.¹¹⁴

The various problems associated with applying the Liability Convention make it apparent that it is insufficient to address the issue of the pollution of the outer space environment by space debris. Not only is it extremely difficult to apply the Liability Convention to situations of actual damage, but it is clear that states cannot be held responsible under the convention for the mere presence of debris in orbit. Because it is difficult to hold states liable, and because states have little to fear in terms of liability for damage caused in orbit, the convention provides no incentive for states to limit the amount of debris they generate. Therefore, the Liability Convention, like the Outer Space Treaty, is ineffective as a tool to regulate the proliferation of space debris.

C. THE REGISTRATION CONVENTION AND THE RETURN AND RESCUE AGREEMENT

On September 15, 1976, the Convention on Registration of Objects Launched into Outer Space¹¹⁵ (Registration Convention) came into force. The drafters designed the Registration Convention to supplement the Liability Convention by aiding in the identification of space objects launched into orbit. In addition, the Registration Convention represents an extension of the principles contained in

¹¹² McDermott, *supra* note 16, at 156.

¹¹³ BAKER, *supra* note 4, at 86.

¹¹⁴ Lampertius, *supra* note 5, at 463. When the Liability Convention was being drafted, the then Soviet Union adamantly opposed the imposition of absolute liability for damage which occurred in orbit. *Id.*

¹¹⁵ Registration Convention, *supra* note 42.

Article VIII of the Outer Space Treaty regarding jurisdiction and control of space objects.¹¹⁶

The Registration Convention provides: "When a space object is launched into earth orbit or beyond, the launching State shall register the space object by means of an entry in an appropriate registry which it shall maintain."¹¹⁷ The launching states must also notify the Secretary-General of the United Nations that they have established these registries.¹¹⁸ Once the launching state has entered the space object into its own registry, it must provide certain information about the object to the Secretary-General, who will enter that information into a master registry.¹¹⁹

Under the Registration Convention, a state must only comply with those provisions in identifying the objects it launches into space.¹²⁰ Although the Registration Conven-

¹¹⁶ See *supra* notes 74-76 (discussing art. VIII of the Outer Space Treaty).

¹¹⁷ Registration Convention, *supra* note 42, art. II(1). Each state determines the content of its registry. *Id.* art. II(3).

¹¹⁸ *Id.* art. II(1).

¹¹⁹ *Id.* art. III(1). Art. IV provides:

1. Each State of registry shall furnish to the Secretary-General of the United Nations, as soon as practicable, the following information concerning each space object carried on its registry:

- (a) Name of launching State or States;
- (b) An appropriate designator of the space object or its registration number;
- (c) Date and territory or location of launch;
- (d) Basic orbital parameters, including:
 - (i) Nodial period,
 - (ii) Inclination,
 - (iii) Apogee,
 - (iv) Perigee;
- (e) General function of the space object.

2. Each State of registry may, from time to time, provide the Secretary-General of the United Nations with additional information concerning a space object carried on its registry.

3. Each State of registry shall notify the Secretary-General of the United Nations, to the greatest extent feasible and as soon as practicable, of space objects concerning which it has previously transmitted information, and which have been but no longer are in earth orbit.

Id. art. IV.

¹²⁰ Article V of the convention does provide that, if a space object is marked with the designation or registration number discussed in article IV, the launching state must also notify the Secretary-General of this fact. *Id.* However, the convention does not require the object to be marked in such a manner.

tion's purpose is to aid in the identification of space objects and the determination of their nationality, its provisions really only assist in determining nationality for purposes of jurisdiction.¹²¹ The determination of the identity of the space object is left to individual states that have the capability to monitor and track the objects.¹²² "As a result, identification will often depend on the willingness of the state most likely to face liability to co-operate in the process of identification."¹²³

One of the reasons why the possibility of identification is not improved under the Registration Convention is that the convention requires a launching state to provide only a very limited amount of information. The mandatory orbital information required under Article IV is not particularly useful for trackable objects, and it has no relation whatsoever to the problem of space debris.¹²⁴ A state may provide additional information concerning its space objects, but this option is entirely at the individual state's discretion.¹²⁵

Probably the most glaring omission of required information, in terms of the problem of space debris, is the fact that launching states are not required to notify the Secretary-

¹²¹ BAKER, *supra* note 4, at 76. The lack of identification capabilities, however, hampers any attribution of nationality. *Id.*

¹²² Article VI of the convention provides:

Where the application of the provisions of this Convention has not enabled a State Party to identify a space object which has caused damage to it or to any of its natural or juridical persons, or which may be of a hazardous or deleterious nature, other State Parties, including in particular States possessing space monitoring and tracking facilities, shall respond to the greatest extent feasible to a request by that State Party, or transmitted through the Secretary-General on its behalf, for assistance under equitable and reasonable conditions in the identification of the object. A State Party making such a request shall, to the greatest extent feasible, submit information as to the time, nature and circumstances of the events giving rise to the request. Arrangements under which such assistance shall be rendered shall be the subject of agreement between the parties concerned.

Registration Convention, *supra* note 42, art. VI.

¹²³ BAKER, *supra* note 4, at 76.

¹²⁴ *Id.* at 77. Baker notes that more useful information would include the orientation of the orbit, the current or initial position of the object, notice of imminent re-entry, or notice of changes in the orbit after launch. *Id.*

¹²⁵ Registration Convention, *supra* note 42, art. IV(2).

General of the breakup or fragmentation of their space objects.¹²⁶ Article IV(3) merely provides that each state "shall notify the Secretary-General of the United Nations, to the greatest extent feasible and as soon as practicable, of space objects concerning which it has previously transmitted information, and which have been but no longer are in earth orbit."¹²⁷ This provision might be applicable to situations involving a satellite breakup but, again, that determination would depend upon the scope of the term space object.

The Registration Convention, along with the Outer Space Treaty and the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space¹²⁸ (Return and Rescue Agreement), also has an impact on the determination of whether debris or other space objects can be removed from orbit by someone other than the launching state. As stated earlier, the Outer Space Treaty provides for the retention of jurisdiction and control over an object by the state which registers the launch of the object.¹²⁹ The language of Article VIII is very clear and leaves little doubt that other states may not destroy or remove the space object (or component parts) of another state without permission.¹³⁰ The Return and Rescue Agreement, however, does provide for states to exercise a limited amount of control over another state's space object if that object has returned to Earth.¹³¹

Whether or not one state may exercise any control over another's space debris is subject to debate. One commentator has suggested that, if debris is not included within the definition of space object, then the debris would not be subject to the continuing registration required by the Registration Convention and could be removed or eliminated

¹²⁶ Leinberg, *supra* note 21, at 105.

¹²⁷ Registration Convention, *supra* note 42, art. IV(3).

¹²⁸ Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, *opened for signature* Apr. 22, 1968, 19 U.S.T. 7570 [hereinafter Return and Rescue Agreement].

¹²⁹ Outer Space Treaty, *supra* note 63, art. VIII.

¹³⁰ Stamps, *supra* note 105, at 154.

¹³¹ Return and Rescue Agreement, *supra* note 128, art. V(1).

without fear of repercussions under international law.¹³² Another commentator contends that it is the Return and Rescue Agreement, not the Registration Convention, which provides the authority to remove another state's debris. Article V(4) of the agreement provides:

Notwithstanding paragraphs 2 and 3 of this Article, a Contracting Party which has reason to believe that a space object or its component parts discovered in territory under its jurisdiction, *or recovered by it elsewhere*, is of a *hazardous or deleterious nature* may so notify the launching authority, which shall immediately take effective steps, under the direction and control of said Contracting Party, to eliminate possible danger of harm.¹³³

Stamps argues that, since portions of the Agreement are specifically limited to the Earth and other portions are not (because Article V(4) contains no such limiting language), states may recover the debris of other states because it is "hazardous or deleterious."¹³⁴

These approaches, however, ignore one of the basic problems of space debris, that of identification. The vast majority of debris is not attributable to a particular launching state, and the debris that is identifiable does not present the greatest hazard.¹³⁵ The fact that most debris is unattributable actually makes it easier to remove it because, as Wirin noted, it would not be covered by any of the international treaty problems.¹³⁶ The Outer Space Treaty provisions governing jurisdiction and control would not apply simply because there is no way to know to whom the debris belonged in the first place. The Registration Convention

¹³² Wirin, *supra* note 46, at 50. Wirin had previously stated that, "[i]n order to legally interfere with debris caused by another launching Nation under customary international law, there is the requirement that the State expressly relinquish ownership and jurisdiction." Wirin, *supra* note 31, at 187. He goes on to note that the United States' position is that even a long period of abandonment does not necessarily relinquish a party's rights. *Id.*

¹³³ Return and Rescue Agreement, *supra* note 128, art. V(4) (emphases added).

¹³⁴ Stamps, *supra* note 105, at 155-56.

¹³⁵ See *supra* notes 122-25 and accompanying text (discussing problems with identification of debris).

¹³⁶ Wirin, *supra* note 46, at 49-50.

provisions would also meet the same fate, as would the Return and Rescue Agreement provisions.

V. NATIONAL SPACE DEBRIS POLICIES

A. UNITED STATES

1. *Generally*

Although international law provides some guidance to the problems associated with space debris, many of the spacefaring nations are not waiting for it to provide a definitive answer. The United States, as one of the major space nations, has taken the lead in addressing the issue. What began as a hodge-podge of efforts among various agencies and departments has become a permanent part of United States space policy.¹³⁷

2. *NASA Policy*

The National Aeronautic and Space Administration (NASA) oversees all U.S. government launches.¹³⁸ Because of the enormous role it plays in the launch industry, NASA policy has been tremendously influential in the space debris area. NASA began to approach the problem of space debris at the policy level in 1981, when it developed a ten year plan to address the topic.¹³⁹ The purpose of the plan was to "define the activities and resources required over the next ten years to develop the necessary understanding of the man-made orbital debris environment"¹⁴⁰ Eventually, the plan was to lead to the development of international space debris agreements.¹⁴¹ The plan itself was divided into several major areas, including debris hazard assessment, debris environment assessment, and space object management.¹⁴²

¹³⁷ BAKER, *supra* note 4, at 111.

¹³⁸ *Id.*

¹³⁹ Schwetje, *supra* note 25, at 168.

¹⁴⁰ BAKER, *supra* note 4, at 112 (citation omitted).

¹⁴¹ Schwetje, *supra* note 25, at 168.

¹⁴² Leinberg, *supra* note 21, at 106.

At the time, NASA also implemented several policies designed immediately to impact the creation of orbital debris. These included: (1) design of objects to reduce the possibility of breakup; (2) development of the capability to measure the debris population beyond that currently available; (3) re-entry of used rocket stages; and (4) assessment of the impact of space debris on the placement of "either large structures or a large number of objects in Earth orbit."¹⁴³

These same goals are also reflected in a strategy implemented by NASA in 1987. Under this strategy, the agency utilized computer modeling to help estimate the debris population and began to design and develop radar capable of tracking very small debris objects.¹⁴⁴ NASA also increased research on materials to reduce the creation of debris and hastened development of shielding and protective devices.¹⁴⁵

NASA has recognized, however, that it cannot resolve the space debris problem single-handedly. In light of this fact, it initiated formal discussions with nations that have active space programs.¹⁴⁶ While these efforts began informally, several of the entities approached by NASA began to develop policies or established working groups to work with the United States in reducing space debris.¹⁴⁷ Because of NASA's pro-active measures, it has been suggested that the agency's plan become the basis for international policy.¹⁴⁸

3. *Department of Defense*

The United States Department of Defense has also been seriously concerned about the impact that space debris

¹⁴³ BAKER, *supra* note 4, at 113.

¹⁴⁴ *Id.*

¹⁴⁵ *Id.*

¹⁴⁶ Joseph P. Loftus, Jr. & Andrew E. Potter, *United States Studies in Orbital Debris Prevention and Mitigation*, PROC. 33D COLLOQUIUM L. OUTER SPACE 408, 413 (1990). Informal and/or formal discussions have taken place with the European Space Agency, Canada, the former Soviet Union, Germany, China, Australia, India, Indonesia, Israel, Italy, Britain, and Brazil. *Id.*

¹⁴⁷ *Id.* at 414.

¹⁴⁸ BAKER, *supra* note 4, at 113.

might have on national security.¹⁴⁹ In 1986, the Department of Defense initiated a study to ascertain whether the possible dangers posed by debris were serious enough to warrant further action. This study found: "[S]pace debris represents a growing problem whose seriousness depends on future traffic and debris management. Even with careful control of future debris events, the level of debris . . . will increase through fragmentation collisions of orbiting objects."¹⁵⁰

The United States Air Force (USAF) Science Advisory Board, which conducted the study, also issued several recommendations.¹⁵¹ While not all of these recommendations were carried out, in March of 1987, then Secretary of Defense Caspar Weinberger signed a Department of Defense Policy Statement which stated: "[Department of Defense] will seek to minimize the impact of space debris on its military operations. Design and operation of [Department of Defense] space tests, experiments and systems will strive to minimize or reduce the accumulation of space debris consistent with mission requirements."¹⁵² By issuing this statement, the "United States became the first major Western space power to recognize the problems posed by space debris to the use of outer space."¹⁵³

As a result of this policy statement, the Department of Defense and the USAF have implemented several programs

¹⁴⁹ Schwejje, *supra* note 25, at 166. "It has been predicted that the Archduke Francis Ferdinand of World War III may well be a critical U.S. or Soviet satellite hit by a space junk during a crisis." *Id.*

¹⁵⁰ BAKER, *supra* note 4, at 115 (quoting SPECIAL REPORT OF THE USAF SCIENTIFIC BOARD AD HOC COMMITTEE ON CURRENT AND POTENTIAL TECHNOLOGY TO PROTECT AIR FORCE SPACE MISSIONS FROM CURRENT AND FUTURE DEBRIS (August 1987)).

¹⁵¹ The Board recommended that uniform design and specification practices be adopted and that the United States help set up an international commission on space debris to "encourage cooperative measurements and exchange of data on the debris environment, . . . implement agreed upon specifications and design practices for future space systems, and . . . encourage international co-operation in dealing with hazardous events and warnings of potential collisions." The report also recommended the minimization of the creation of space debris by weapon systems, particularly by the development of new systems and materials, and continued research. BAKER, *supra* note 4, at 115-16.

¹⁵² Leinberg, *supra* note 21, at 107.

¹⁵³ McDermott, *supra* note 16, at 156.

or policies. They have planned experiments to measure the amount of debris in Low Earth Orbit and designed tests to determine the impact the debris has on manned and unmanned space vehicles.¹⁵⁴ In addition, the Department of Defense is developing protective shielding for vehicles and increasing their maneuverability while also designing these vehicles to avoid the possibility of breakup in a collision.¹⁵⁵

In the view of several commentators, however, the Department of Defense Policy Statement, while a good beginning, was flawed from the start.¹⁵⁶ The policy did not provide for the elimination of debris generation, but merely sought to minimize debris generation consistent with national security interests.¹⁵⁷ Thus, if a mission necessary for national security required the generation of significant amounts of debris, the mission would still be acceptable and consistent with the Department policy.¹⁵⁸ In addition, the policy has been criticized because it does not advocate the elimination of all debris, but only the minimization of debris generation.¹⁵⁹

4. *Department of Transportation*

An increasingly important and expanding area of space activity is the commercial space launch industry.¹⁶⁰ The U.S. government recognized the importance of this industry and began regulating commercial launches through the

¹⁵⁴ Schwetje, *supra* note 25, at 166.

¹⁵⁵ BAKER, *supra* note 4, at 116-17.

¹⁵⁶ See, e.g., BAKER, *supra* note 4, at 116; Leinberg, *supra* note 21, at 107.

¹⁵⁷ Leinberg, *supra* note 21, at 107.

¹⁵⁸ It should be noted that some amount of debris generation is a practical necessity consistent with current space activities. *Id.*

¹⁵⁹ BAKER, *supra* note 4, at 116. While total elimination of space debris may not be realistic or even necessary, Baker believes that, "if the objective of research and development programmes were elimination of space refuse, the end result would likely yield greater reductions than those flowing from the more relaxed goal of minimization." *Id.*

¹⁶⁰ Edward R. Finch, *Future Space Commercialization and Space Debris*, PROC. 34TH COLLOQUIUM L. OUTER SPACE 168, 169 (1991). The United States, the Arianespace Group, Japan, France, China, and the former Soviet Union are all competitors in the space launch industry which was worth an estimated \$2 billion to the United States alone in 1991. *Id.*

Commercial Space Launch Act of 1984.¹⁶¹ While the Act does not specifically refer to space debris, the Office of Commercial Space Transportation (OCST) apparently has the authority to require commercial launches to minimize debris generation.¹⁶² The Commercial Space Launch Act of 1984 provides:

The Secretary [of Transportation] may, consistent with the public health and safety, safety of property, and national security interests and foreign policy interests of the United States, issue or transfer a license for launching one or more launch vehicles or for operating one or more launch sites, or both, to an applicant who meets the requirements for a license under section 2607 of this title.¹⁶³

The language relating to the safety of property, namely, other space objects, may authorize the OCST to consider debris generation as a factor in its license review process.¹⁶⁴ In addition, the OCST may also have the authority to mandate the minimization of debris generation because debris may adversely affect the foreign policy or national security interests of the United States.¹⁶⁵

Generally, an entity must procure a license before it can launch a vehicle with a payload into orbit.¹⁶⁶ The applica-

¹⁶¹ 49 U.S.C. app. §§ 2601-2623 (1988 & Supp. V 1993). "No person shall launch a launch vehicle or operate a launch site within the United States, unless authorized by a license issued or transferred under this chapter." *Id.* § 2605(a)(1). In addition, no U.S. citizen can launch a vehicle or operate a launch site outside the United States, regardless of whether it is within the territory of any other nation, without a license. *Id.* § 2605(a)(2)-(3).

¹⁶² 14 C.F.R. § 401.1 (1993).

¹⁶³ 49 U.S.C. app. § 2606.

¹⁶⁴ Pamela L. Meredith, *Legal Implementation of Orbital Debris Mitigation Measures: A Survey of Options and Approaches*, 6 AM. U.J. INT'L L. & POL'Y 203, 210 (1991). In addition, the Act provides that the Secretary of Transportation, through the OCST, can "prescribe such additional requirements as are necessary to protect the public health and safety, safety of property, and national security interests and foreign policy interests of the United States." 49 U.S.C. app. § 2607(b).

¹⁶⁵ BAKER, *supra* note 4, at 114. Since adherence to international treaties is an aspect of foreign policy, OCST action could be appropriate if the treaties are applicable to space debris. *Id.*

¹⁶⁶ 14 C.F.R. § 415.3(a) (1993) provides:

The launch of a launch vehicle from U.S. territory by any person, or from outside U.S. territory by any individual or any corporation, partnership, joint venture, association of other entity organized or existing

tion review procedure is a two step process consisting of a safety review and a mission review.¹⁶⁷ An application must include information on:

- (1) The launch vehicle stages and its payload, including evaluations of mission hardware reliability and safety performance
- (2) Mission planning and Expendable Launch Vehicle (ELV) design
- (3) Parking and transfer orbits for spent rocket stages
- (4) Evaluations of the orbital life of spent stages and the probable impacts during reentry
- (5) Collision probability with active payloads that could be jeopardized by the debris of the mission under review
- (6) Safety of orbital operations, e.g., venting propellants to prevent accidental explosions
- (7) The types, likelihood, and consequences of on-orbit failures of ELVs.¹⁶⁸

In addition to the launch vehicle, the OCST has the authority to regulate some payloads launched by commercial entities, but certain federal agencies have jurisdiction in particular instances.¹⁶⁹ The Federal Communication Commission (FCC) is responsible for commercial telecommunications satellites,¹⁷⁰ while the National Oceanic and Atmospheric Administration (NOAA) licenses commercial remote-sensing satellites.¹⁷¹

under the laws of the United States or any state, must be authorized by a license issued under this part.

¹⁶⁷ 14 C.F.R. § 411.3 (1994); *see also* Wirin, *supra* note 31, at 187. Because debris generation is related to mission safety, it falls within the purview of the Office of Commercial Space Transportation (OCST). Wirin, *supra* note 31, at 187. Specifically, the OCST looks at the "ELV staging and maneuvering hardware" for quality and reliability as well as at the proposed orbit, orbital life, and trajectory of the vehicle. *Id.* The application must also include plans on how the vehicle will vent unused propellants and pressurants in rocket stages left in orbit to prevent explosion. *Id.*

¹⁶⁸ Leinberg, *supra* note 21, at 108.

¹⁶⁹ 14 C.F.R. § 411.7(b) (1994). "A proposal to launch any foreign payload or a payload not covered by existing FCC or NOAA regulation must be reviewed in consultation with other appropriate Federal agencies" *Id.*

¹⁷⁰ 47 U.S.C. §§ 151-52 (1988 & Supp. V 1993).

¹⁷¹ 15 U.S.C. §§ 5621-72 (Supp. V 1993).

The FCC's regulatory power may be applicable to the problem of space debris. It has the power to control the orbital location of each satellite licensee in addition to the general ability to regulate.¹⁷² By controlling the orbital location of a satellite, or requiring the satellite to be moved, the FCC could require satellites to either be boosted into disposal orbits or deorbited into controlled reentries at the end of their useful lives.¹⁷³ This would have the effect of removing an inactive space object from orbit and preventing it from colliding with, or being struck by, another space object, thus reducing the risk of debris generation. However, "[t]o date, the FCC has not attempted to regulate the debris aspects of telecommunications satellite operations [by requiring] disposal of satellites at the end of useful life" ¹⁷⁴

The NOAA, like the FCC, also appears to have the authority to require satellite operators to utilize disposal orbits at the end of a satellite's useful life.¹⁷⁵ NOAA's regulations require any licensee to dispose of its satellite in a satisfactory manner.¹⁷⁶ Once the NOAA determines what would be a satisfactory manner, it appears that the determination would have to be approved by the President.¹⁷⁷

If the FCC or NOAA does not have jurisdiction over the payload in question, the OCST provisions are applicable.¹⁷⁸ Generally, unless the proposed mission or payload represents a threat to U.S. interests or poses a hazard to public health and safety, or the safety of property, the mission will be approved.¹⁷⁹

¹⁷² 47 U.S.C. § 303(d) (1988).

¹⁷³ Meredith, *supra* note 164, at 210.

¹⁷⁴ *Id.* at 208. Even though the FCC does not require it, some satellite operators consistently boost their geostationary satellites into disposal orbits when they are no longer useful. *Id.*

¹⁷⁵ *Id.* at 211.

¹⁷⁶ 15 C.F.R. § 960.11(d) (1995).

¹⁷⁷ 15 U.S.C. § 5633(f) (Supp. V. 1993); Meredith, *supra* note 164, at 212; Wirin, *supra* note 31, at 187.

¹⁷⁸ 14 C.F.R. § 411.7(b) (1994).

¹⁷⁹ *Id.*

The solution provided by the OCST provisions is consistent with the Commercial Space Launch Act's congressional findings.¹⁸⁰ The purpose of the Act was to facilitate the development of the private commercial space industry.¹⁸¹ In accordance with this purpose, the Congress found U.S. interests would be furthered by "stable, *minimal*, and appropriate regulatory guidelines that are fairly and expeditiously applied."¹⁸² This fact would seem to discourage stringent regulation of commercial launches based on the amount of debris, within reason, that they might generate.¹⁸³ By applying overly restrictive regulations, the OCST could place the U.S. commercial space industry at a competitive disadvantage relative to the other world space powers.¹⁸⁴ This result would not only be inconsistent with the intentions of the Commercial Space Launch Act, but it would also be inconsistent with general U.S. space policy.¹⁸⁵

¹⁸⁰ 49 U.S.C. app. § 2601 (1988 & Supp. V 1993).

¹⁸¹ *Id.* § 2602(2).

¹⁸² *Id.* § 2601(6) (emphasis added). In addition, the act states:

[T]he United States should encourage private sector launches and associated services and, *only to the extent necessary*, regulate such launches and services in order to ensure compliance with international obligations of the United States and to protect the public health and safety, safety of property, and national security interests and foreign policy interests of the United States.

Id. § 2601(7) (emphasis added).

¹⁸³ However, general U.S. policy does indicate a desire to reduce space debris whenever it does not conflict with another important goal or policy of the United States. See *infra* note 186 and accompanying text (discussing President Reagan's National Space Policy).

¹⁸⁴ Meredith, *supra* note 164, at 211.

¹⁸⁵ President Reagan's National Space Policy, which did discuss minimizing the creation of space debris, stated that any regulation of the commercial launch industry "must not necessarily prejudice involvement and international competitiveness of the U.S. commercial space industry." Wirin, *supra* note 31, at 188. President Bush's national space policy also acknowledged the importance of the commercial space industry. It stated:

[E]xpanding private sector investment in space by the market-driven commercial sector generates economic benefits for the nation and supports governmental space sectors with an increasing range of space goods and services. Governmental space sectors shall purchase commercially available space goods and services to the fullest extent feasible and shall not conduct activities with potential commercial applications that preclude or deter commercial sector space activities

....

5. Overall Policy

The problem of space debris has been addressed, to a limited extent, at the highest levels of U.S. government. In January 1988, President Reagan signed a National Space Policy which provided: "All space sectors will seek to minimize the creation of space debris. Design and operations of space tests, experiments and systems will strive to minimize or reduce accumulation of space debris consistent with mission requirements and cost effectiveness."¹⁸⁶ This policy constituted an important precedent because it was the "first public statement by the chief executive officer of a major space power on the subject of space [debris]."¹⁸⁷ The policy itself was apparently developed from the Department of Defense policy which had been instituted in 1987.¹⁸⁸ However, while the Department of Defense policy sought to "minimize the impact of space debris," the National Space Policy focused on minimizing the "creation of space debris." Thus, the National Space Policy reflected a greater commitment to actually curtailing the overall space debris problem.

This increased commitment was also evident in the establishment of the Interagency Group (Space) for the National Security Council. This working group was to provide recommendations for a space debris policy and was assigned five specific tasks:

- (1) Define the dimensions of the current and projected space debris problem
- (2) Review existing agency debris policies and activities
- (3) Review options for reducing the production of space debris and minimizing its hazards to spacecraft
- (4) Recommend approaches to other governments

Finch, *supra* note 160, at 169.

¹⁸⁶ BAKER, *supra* note 4, at 118 (quoting OFFICE OF THE PRESS SECRETARY, THE WHITE HOUSE, FACT SHEET: NATIONAL SPACE POLICY 1 (Jan. 26, 1988)).

¹⁸⁷ *Id.* at 120.

¹⁸⁸ See *supra* note 152 and accompanying text (discussing Department of Defense policy on space debris).

(5) Recommend areas for potential future research regarding debris environment measurement and protection techniques.¹⁸⁹

A working group, co-chaired by NASA and Department of Defense officials, prepared the final report (Interagency Report) and submitted it in February 1989.¹⁹⁰ The Interagency Report made several important findings and recommendations. The group found that, due to the limited capability to measure the actual debris population, the urgency of action might not be as extreme as had been suggested.¹⁹¹ However, the Interagency Report did note that, unless efforts were made to limit debris generation, space operations would be jeopardized in the future.¹⁹²

The Interagency Report recommended that, consistent with President Reagan's National Space Policy, all future space missions should be designed to minimize the creation of new space debris.¹⁹³ It also recommended the development of research plans by government agencies to address space debris.¹⁹⁴ NASA and the Department of Defense, along with the Department of Transportation, developed these plans which, not surprisingly, paralleled each agency's previous attitude toward the generation of debris.¹⁹⁵ In short, they all agreed that the minimization of debris generation should be a design consideration for subsequent space activities, although the Department of Transportation was concerned about the possible impact this

¹⁸⁹ Leinberg, *supra* note 21, at 106.

¹⁹⁰ See INTERAGENCY REPORT, *supra* note 7.

¹⁹¹ Col. Robert L. Bridge & Lt. Col. Milton L. Smith, *Space Debris: A Role for Lawyers?*, PROC. 33D COLLOQUIUM L. OUTER SPACE 266 (1990); see also Wirin, *supra* note 31, at 186.

¹⁹² Bridge & Smith, *supra* note 191, at 266.

¹⁹³ *Id.*

¹⁹⁴ *Id.* Efforts to study and measure the debris environment are currently underway as a result of these plans. See O'Brien, *supra* note 2 (discussing Satellite Orbital Debris Characterization Impact Test); Chris Stagg, *Cheap Mercury Mirror Puts New Spin on Star-Gazing*, CALGARY HERALD, Aug. 7, 1993, at B6 (discussing NASA's construction of a mercury mirror to increase debris detection capability).

¹⁹⁵ Bridge & Smith, *supra* note 191, at 266.

might have on the commercial space industry.¹⁹⁶ While this is basically what was mandated by the National Space Policy of 1988, the research plans prepared by the groups provided for a cohesive, long-term effort to study the debris environment and develop debris mitigation capabilities.¹⁹⁷

B. EUROPE

1. *European Space Agency*

The European Space Agency (ESA), like the United States, established a working group to study "all aspects of space debris which may have a detrimental effect on activities on ground and in space."¹⁹⁸ This group presented its report in November 1988¹⁹⁹ and came to conclusions similar to those their American counterparts would release three months later. The ESA Report recognized that, while space debris was not yet an imminent threat to manned or unmanned space activities, a "conscious policy aimed at curbing the growth of debris" must be adopted.²⁰⁰

One of the primary ways the ESA is seeking to improve the debris situation is through the development of radar and telescopic facilities to monitor and measure the debris environment.²⁰¹ Currently, the United States and the former Soviet Union are the major sources of information concerning the debris population. However, work on a European tracking system is currently underway,²⁰² and it is hoped that this work will lead to a significant increase in the available information concerning space debris.

¹⁹⁶ See *supra* notes 138-85 and accompanying text (discussing NASA, Department of Defense, and Department of Transportation policies).

¹⁹⁷ Bridge & Smith, *supra* note 191, at 267; see also BAKER, *supra* note 4, at 119.

¹⁹⁸ BAKER, *supra* note 4, at 110.

¹⁹⁹ *Space Debris: A Report of the ESA Space Debris Working Group*, European Space Agency, ESA SP 1109 (1988) [hereinafter *ESA Report*].

²⁰⁰ Wirin, *supra* note 31, at 188 (quoting *ESA Report*, *supra* note 199, at 8).

²⁰¹ Leinberg, *supra* note 21, at 109; Wirin, *supra* note 31, at 188-89.

²⁰² British scientists have completed a study for the ESA which designed a sophisticated telescope to automatically detect and monitor some of the smallest debris fragments. Steve Connor, *Scientists Find Way of Detecting Space Junk*, THE INDEPENDENT, June 25, 1993, at 3.

The European approach to the creation of debris is similar to that which the United States has taken. The ESA has begun designing its missions to avoid the probability of a collision in space that would produce debris and has striven to use disposal orbits for inactive satellites.²⁰³ The ESA also has plans to shield ESA spacecraft to prevent damage and debris resulting from collisions²⁰⁴ and to alter the design and operations of its rockets to reduce the chance of explosions.²⁰⁵

In addition to internal actions, the ESA held the first European Space Debris Conference in Germany in April 1993.²⁰⁶ This multilateral conference was apparently the first to involve representatives from the ESA, the Russian Space Agency, NASA, China, India, and Japan, among others.²⁰⁷ However, no earth-shattering revelations were announced at the conference. As expected, the conference concluded that the long-term hazard of space debris presents a great threat, and that this threat will require preventive measures to address the situation properly.²⁰⁸ The most significant accomplishments of the conference were the itemization of the approximately 7100 identifiable items of space debris and plans by the ESA to hold another conference in two years.²⁰⁹

²⁰³ Leinberg, *supra* note 21, at 109. For example, Meteosat-2, a meteorological satellite, was boosted 87 miles farther out into space from GEO in late 1991 into a "graveyard orbit" to prevent it from colliding with other space objects. Rolf Soderlind, *Dead European Satellite Enters "Graveyard Orbit"*, REUTER NEWswire, Dec. 3, 1991.

²⁰⁴ A European Satellite known as ERECA, which was retrieved by the space shuttle Endeavor in June 1993 after 11 months in orbit, was struck at least 30 times by debris, either natural or man-made. The largest of the impacts left a quarter-inch dent which could have seriously crippled the spacecraft if the impact had been in a critical area. Luckily, however, and somewhat ironically, the debris struck an experiment on the craft that was designed to gather data on debris hits. Todd Halvorson, *European Craft Ready for Another Launch*, FLA. TODAY, Aug. 19, 1993.

²⁰⁵ Leinberg, *supra* note 21, at 109.

²⁰⁶ *International Experts Propose Bilateral Talks to Solve Space Debris Problem*, SATELLITE WEEK, Apr. 19, 1993.

²⁰⁷ *Id.* 251 experts from 17 countries attended the conference. *Id.*

²⁰⁸ *Id.* These preventive measures include venting of unused propellants, disposal orbits, and orbiting the vehicle so that it will reenter the atmosphere and burn up when its useful life is finished. *Id.*

²⁰⁹ *Id.* Some feel that a "World Space Agency" would be the best way to secure the safety and environment of outer space, and the European Space Agency has en-

2. *The United Kingdom*

The United Kingdom has passed an act similar to the American Commercial Space Launch Act of 1984 which allows licensing of space activities carried out by U.K. nationals.²¹⁰ Like the U.S. version, the U.K. legislation does not specifically mention space debris.²¹¹ However, some provisions, such as the one that requires U.K. space activities not to threaten the safety of persons or property or diminish U.K. national security, could arguably apply to space debris.²¹² While the statute provides that the Secretary of State has the discretionary power to impose conditions on the licenses it issues, the statute itself sets out several conditions which the Secretary should consider, two of which could apply to space debris. One condition is that an entity seeking a license may be required to prevent contamination of outer space and to avoid interference with the peaceful activities of other users of outer space.²¹³ Another condition is that the Secretary may require payloads to be disposed of in any manner he or she sees fit at the end of their useful life.²¹⁴ An example of this would be to require the use of disposal orbits for satellites.

VI. PROPOSED SOLUTIONS AND RECOMMENDATIONS

While space debris may not pose the immediate danger some believe, it is sufficiently problematic that the world community must address it in some manner. Most of the major space powers have acknowledged this and have be-

dorsed such an idea. Barbara Wood-Kaczmar, *Spring Cleaning: The Nations that Clutter the Heavens are Finally Uniting*, THE GUARDIAN, Apr. 22, 1993, at 13.

²¹⁰ An Act to Confer Licensing and Other Powers on the Secretary of State to Secure Compliance with the International Obligations of the United Kingdom with respect to the Launching and Operation of Space Objects and the Carrying On of Other Activities in Outer Space by Persons Connected with this Country, *reprinted in* 11 ANNALS AIR & SPACE L. 412 (1986) [hereinafter Outer Space Act].

²¹¹ BAKER, *supra* note 4, at 120.

²¹² *Id.*

²¹³ Outer Space Act, *supra* note 210, §§ 5(2)(e)(i), (ii).

²¹⁴ *Id.* § 5(2)(g).

gun taking steps to ameliorate the situation. However, there is no coordinated approach to minimizing space debris. This results in duplicated efforts and inefficient solutions. To develop a coordinated approach, the world community must make several decisions concerning this undertaking.

A. APPROPRIATE FORUM

The world community must decide on an appropriate forum for this issue. Some believe that the proper forum is the United Nations, while others suggest that multilateral or bilateral agreements would be more appropriate. Each approach has distinct advantages and disadvantages, and the following discussion will examine these aspects.

1. *Worldwide Organization/United Nations*

Because space debris is a multinational problem, some commentators feel that the only way to solve it is through a worldwide international convention negotiated through the United Nations or other similar international organizations.²¹⁵ It has been argued that, since outer space is the common heritage of all mankind, all countries have a right to determine the policies and objectives of any organization affecting outer space regardless of their level of involvement in space.²¹⁶ To achieve this objective, authorities maintain that the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) would be an appropriate forum because it is fully representative of the world community.²¹⁷

UNCOPUOS is a body devoted to various outer space issues with representatives from a broad range of nationalities and viewpoints. Its advocates propose that the Scientific and Technical Subcommittee of UNCOPUOS

²¹⁵ See, e.g., Finch, *supra* note 160, at 168.

²¹⁶ BAKER, *supra* note 4, at 159.

²¹⁷ Leinberg, *supra* note 21, at 110. UNCOPUOS has two subcommittees which could assist in the effort. These are the Scientific and Technical Subcommittee and the Legal Subcommittee.

could first lay the technical foundation that would then be acted upon by the Legal Subcommittee.²¹⁸ UNCOPUOS has developed several general and specialized treaties and has recommended certain guidelines for states in their space activities.²¹⁹

Any agreement adopted through UNCOPUOS would be guaranteed to be approved by all of the space powers and a large group of other states.²²⁰ However, UNCOPUOS achievements have only come after "years of preparatory study and painstaking negotiations before a final product could emerge from the committee's consensus procedure."²²¹ Because of the procedure used by UNCOPUOS, it can take nearly a decade before anything results from the committee's work.²²² In addition, the committee is subject to the political whims of its members, who sometimes disregard meritorious proposals because they were initiated by a political opponent or because of some reason completely

²¹⁸ Hobe, *supra* note 67, at 198.

²¹⁹ Stephen E. Doyle, *Regulating Space Debris: What Can Be Done About It?*, PROC. 33D COLLOQUIUM L. OUTER SPACE 421 (1990).

²²⁰ Jürgen Reifarth, *An Appropriate Legal Format for the Discussion of the Problem of Space Debris*, in ENVIRONMENTAL ASPECTS OF ACTIVITIES IN OUTER SPACE, *supra* note 107, at 301, 305. UNCOPUOS has a total of 53 members. *Id.* This fact can also be a disadvantage since many of the states on the committee are not involved in space activities, with the result that irrelevant arguments are at times brought forth. *Id.* at 307. These arguments must be addressed and explained to the delegations, which must then discuss them with their national authorities and return with an answer the following year. *Id.*

²²¹ Doyle, *supra* note 219, at 421. UNCOPUOS requires unanimity in its decision making process, which can lead to long delays. Reifarth, *supra* note 220, at 306.

²²² Reifarth, *supra* note 220, at 306. It took UNCOPUOS almost 10 years each to settle principles regarding direct broadcasting and remote sensing. *Id.* In addition, Reifarth provides an excellent illustration of the political gamesmanship which permeates UNCOPUOS. He states:

This unwieldiness was again revealed impressively at the most recent Legal Subcommittee meeting in spring 1988, when consensus was reached only on the principle of "Applicability of International Law," which includes only well-established and self-evident provisions. Other delegations proposed additional principles which do not contain any novel aspects either. As some delegations consider it expedient to adopt only the principle per year, even well-meant proposals come to nothing. Technical issues are thus in danger of being lost in the tactics oriented discussion within the United Nations.

Id.

unrelated to the relevant issue.²²³ While UNCOPUOS has contemplated putting space debris on its agenda, it has not done so because of the problems associated with defining the scope of the issue and the reluctance of some UNCOPUOS members.²²⁴

Another proposed forum for discussing space debris is the International Telecommunications Union (ITU).²²⁵ Although the ITU's jurisdiction is generally limited to telecommunications systems and satellites, it does have access to some of the best scientists, engineers, and specialists who would be able to address the highly technical issues quickly.²²⁶ Its structural framework lends itself to the development of international regulations through "disciplined and thoughtful" practices.²²⁷ In addition, as a specialized arm of the United Nations, the ITU already has the needed procedures and practices in place to produce effective regulation.²²⁸ Nonetheless, while the ITU could address space debris because of its possible impact on space telecommunications, it is not likely to consider the problem in the near future.²²⁹

2. *Multilateral/Bilateral Negotiations*

While proceeding through the United Nations structure would have the advantage of representation by a large number of states, this fact is also a disadvantage in some instances. The interests of industrialized nations often compete or conflict with those of less developed nations, particularly in the area of environmental regulation.²³⁰ Thus, participation by all, or even a large number of states could result in needless waste and delay.²³¹ Regardless of

²²³ *Id.*

²²⁴ Doyle, *supra* note 219, at 422; *see also* Wirin, *supra* note 31, at 195.

²²⁵ Doyle, *supra* note 219, at 421; BAKER, *supra* note 4, at 159.

²²⁶ Doyle, *supra* note 219, at 421.

²²⁷ *Id.*

²²⁸ *Id.*

²²⁹ *Id.*

²³⁰ Lampertius, *supra* note 5, at 467.

²³¹ *See supra* notes 220-22 and accompanying text (discussing problems with UNCOPUOS).

the delay, participation by all states may not even be necessary. The greatest threat posed by space debris is to other objects in space, not to activities on the Earth's surface.²³² Some believe that "[o]nly those states which are involved in space activities can take an action to contain the production of space debris, and only those states can suffer from damage to space objects caused by debris."²³³

An alternative approach to United Nations action would be to conduct multilateral discussions or negotiations among the active space nations.²³⁴ This approach would have the advantage of involving only knowledgeable states who have a vested interest in concentrating only on the debris problem and not being sidetracked by tangential issues.²³⁵ In addition, many of the space capable nations are already following practices to lessen the amount of debris generated and the impact that debris has on the environment.²³⁶ Because of this, it should not be particularly difficult to reach agreement on accepted policies and practices.²³⁷ Once an agreement is reached, whether it be

²³² Reifarth, *supra* note 220, at 308. It should be remembered, however, that space debris can also interfere with scientific and communications activities based on the Earth's surface. See *supra* notes 36-40 and accompanying text (discussing possible interference caused by space debris).

²³³ Reifarth, *supra* note 220, at 308.

²³⁴ Lampertius, *supra* note 5, at 468; Leinberg, *supra* note 21, at 110; McDermott, *supra* note 16, at 158; Stamps, *supra* note 105, at 153; Wirin, *supra* note 31, at 195.

²³⁵ Lampertius, *supra* note 5, at 467. "Such discussions would have the benefit of eliminating those nations without the capability to launch and thereby eliminate the chance that the discussions may 'becom[e] the subject of acrimonious debate in which technical issues and solutions could be lost.'" McDermott, *supra* note 16, at 158 (quoting U.S. Congress, Office of Technology Assessment, *Orbiting Debris: A Space Environmental Problem—Background Paper*, Sept. 1990, at 36).

²³⁶ See, e.g., Bridge & Smith, *supra* note 191, at 268. Bridge and Smith actually feel that the current approach to space debris is adequate because of the actions of the United States and those of the ESA, Russia, and Japan. *Id.*

²³⁷ However, there are no guarantees of a speedy agreement among the space nations. For example, it required more than two years to reach an agreement on an international space station involving the European Space Agency, the United States, Japan, and Canada. Lampertius, *supra* note 5, at 468.

bilateral or multilateral,²³⁸ it can be used as the basis for future United Nations action.²³⁹

For these reasons, it is advantageous to pursue multilateral negotiations and discussions rather than action through an existing organization. While the debris situation is not as desperate as some believe,²⁴⁰ it still needs to be addressed. By gathering a group focused solely on the issue of space debris, the world community can ameliorate any further damage to the space environment and reduce the future costs to society. Spacefaring nations have already begun discussions, and these negotiations should continue with the goal of an international agreement firmly in mind.

B. CONTENT OF AGREEMENT

Regardless of how the world community reaches an agreement or what form it takes, there are certain areas it must address. Any agreement must clearly define the terms that will be used for the space debris problem. It also needs to increase the information available concerning debris and to disseminate this information to all concerned. In addition, the agreement must develop preventive measures to curtail debris generation, along with practices to remove the debris that is currently in orbit. Finally, any new agreement should expand on the liability provisions contained in the Liability Convention.

1. Definitions

To adequately address the problem of space debris, spacefaring nations must develop an acceptable definition of debris.²⁴¹ Any future agreement must precisely define its terminology, unlike the current space law agreements, "in

²³⁸ A multilateral approach may be preferable to avoid duplicative and inconsistent approaches. *Id.* It should be noted that the spacefaring nations have already participated in a conference to discuss the space debris issue, although no international agreement was pursued or achieved. See *supra* notes 206-09 and accompanying text (discussing European Space Agency's 1993 conference on space debris).

²³⁹ Leinberg, *supra* note 21, at 110; Reifarh, *supra* note 220, at 308.

²⁴⁰ Bridge & Smith, *supra* note 191, at 268.

²⁴¹ Wirin, *supra* note 46, at 50.

order to ensure that provisions are not easily disputed and the standards can be easily understood."²⁴² Currently, it is unclear whether the term space object, as used by the space law agreements, encompasses space debris.²⁴³

To determine if an object is debris, some commentators focus on whether or not it is "valueless,"²⁴⁴ while others look to see whether the object is still under control of the launching authority.²⁴⁵ Yet another possible approach is to develop a laundry list of what is or is not debris.²⁴⁶ The manner in which debris is defined will have an impact not only on any future agreement, but also on the current space law treaties. If debris is not within the scope of the term space object, then the provisions of the Registration Convention and the Liability Convention would not apply.²⁴⁷

Clearly, removing debris from the scope of the Outer Space Treaty and Registration and Liability Conventions could have several positive effects if done in conjunction with the development of an intelligible set of guidelines concerning debris. First, such removal would do away with the contradictory and confusing arguments put forth by commentators. This is important because no strictly judicial or legal pronouncement is forthcoming, nor is a consensus among the commentators likely. Second, the existing international outer space agreements were clearly not intended to address the problem of space debris. By

²⁴² McDermott, *supra* note 16, at 158.

²⁴³ See *supra* notes 41-49 and accompanying text (discussing the term "space object" as used in the space law agreements).

²⁴⁴ BAKER, *supra* note 4, at 156. Baker defines space debris as "those man-made objects in outer space deemed to be valueless, as evidenced by an absence of operational control, and includ[ing] inactive payloads, operational debris, fragmentation debris and microparticulate matter." *Id.*

²⁴⁵ Fasan, *supra* note 50, at 282; Gorove, *supra* note 55, at 97.

²⁴⁶ Kopal, *supra* note 42, at 41.

²⁴⁷ See *supra* note 98 and text accompanying note 132 (discussing the definition of debris and its effect on the Liability Convention, and the removal of debris if it is not included within the definition of space object under the Registration Convention). Removing debris from the aegis of these instruments would have a significant impact on the jurisdiction and control over the object and any liability system for damage by debris.

attempting to shoehorn debris into instruments that were not designed to meet this very specific and technical need, commentators have diverted attention from what is truly needed: a specific agreement on debris. By attempting to shoehorn debris into instruments that were not designed to meet this very specific and technical need, commentators have diverted attention from what is truly needed: a specific agreement on debris.

It appears that a good approach is to define space debris as man-made objects, including former space objects, that, through natural processes, are no longer under the control of the registering entity and that serve no useful purpose. This definition would have the effect of limiting space objects to currently functioning objects while opening the debris category to formerly operational, yet still intact, satellites in addition to the traditional idea of debris. As debris, these objects would no longer be subject to the continuing jurisdiction and control of the launching entity as contemplated by the Outer Space Treaty and Registration Convention. Although satellite owners might fear the loss of the satellite after the end of its useful life, this definition would provide an incentive to arrange for the proper disposal of the satellite.²⁴⁸ If the owner had not done so, then it could not complain about the later removal of the debris.

2. *Available Information*

Once the international community decides what constitutes debris, it must develop better means of measuring the debris population.²⁴⁹ Currently, there is no international system for obtaining and evaluating information on tracka-

²⁴⁸ The requirement that loss of control of the object occur through natural processes would curtail any wrongdoing in the form of states pirating other nations' space objects.

²⁴⁹ Felske, *supra* note 35, at 419; Leinberg, *supra* note 21, at 100; Lubos Perek, *Technical Aspects of the Control of Space Debris*, PROC. 33D COLLOQUIUM L. OUTER SPACE 400, 405 (1990); David E. Reibel, *Prevention of Orbital Debris*, PROC. 30TH COLLOQUIUM L. OUTER SPACE 147, 152 (1987); Tatsuzawa, *supra* note 50, at 174.

ble objects,²⁵⁰ and the capability to track very small pieces of debris is extremely limited.²⁵¹ One commentator proposed that tracking improvements could come from enhanced ground-based radar or from a series of space debris monitoring posts shared by the spacefaring nations.²⁵² Although individual nations are pursuing increased tracking capabilities, the costs of these are enormous.²⁵³ If the spacefaring nations shared the costs of these projects, then they could achieve greater progress with less duplication of efforts. In addition, they could develop improved systems in a shorter period of time which would then allow the nations to devote their resources to reducing the amount of debris instead of just measuring it.

To be effective, the spacefaring nations must share and distribute this information amongst themselves and the world community. This could be accomplished through the register maintained by the U.N. Secretary-General²⁵⁴ or through some entity currently not in existence. While some commentators believe the space debris problem needs a separate system or management organization,²⁵⁵ the current U.N. register would probably be adequate if given sufficient information. The register would have to be updated rapidly as the nations gather more information, and all nations involved in space must participate completely if efforts to reduce debris are to prove successful.

3. *Preventive Measures*

Because the true extent and nature of the space debris problem is not known, it is impossible to state precisely what actions will prove most effective in remedying the de-

²⁵⁰ Perek, *supra* note 249, at 405. Most of the information about the debris population comes from U.S. facilities. *Id.*

²⁵¹ Leinberg, *supra* note 21, at 110.

²⁵² *Id.*

²⁵³ *Id.*; see also *supra* notes 190-97, 210-14 and accompanying text (discussing U.S. and U.K. efforts to improve detection capabilities).

²⁵⁴ See *supra* note 119 and accompanying text (discussing the Secretary-General's master registry).

²⁵⁵ See, e.g., Tatsuzawa, *supra* note 50, at 174.

bris situation. Spacefaring nations, however, can take many actions that would be helpful in limiting the future amount of debris generated and even reducing the current debris population. The following is a list of some well-accepted ideas to reduce debris:

1. Design spacecraft to reduce the possibility of explosions or fragmentation upon collision, including shielding.²⁵⁶
2. Vent unused fuel or propellants to reduce the chance of unintentional explosions.²⁵⁷
3. Utilize parking and transfer orbits for planned reentry of objects into the atmosphere.²⁵⁸
4. Utilize graveyard orbits for satellites at the end of their useful life in GEO. This would require saving enough fuel to accomplish the transfer.²⁵⁹
5. Redesign space objects to meet more than one need simultaneously, thus reducing the number of objects in orbit.²⁶⁰
6. Evaluate planned missions using the amount of debris they might generate as a major criteria.²⁶¹
7. Increase the maneuverability of spacecraft so they can avoid collisions.²⁶²
8. Initiate retrieval of debris or inactive satellites, by specially designed spacecraft.²⁶³
9. Select orbital parameters and launch windows to minimize the chance of collision.²⁶⁴

²⁵⁶ See, e.g., BAKER, *supra* note 4, at 158. Although it should be easy to gain acceptance for design regulations, new and emerging space powers might object to some of the more costly requirements. Leinberg, *supra* note 21, at 111. To alleviate this problem, economic or technical assistance should be available to those countries.

²⁵⁷ See, e.g., Felske, *supra* note 35, at 419.

²⁵⁸ See, e.g., Stamps, *supra* note 105, at 158.

²⁵⁹ See, e.g., Leinberg, *supra* note 21, at 113.

²⁶⁰ See, e.g., Tatsuzawa, *supra* note 50, at 174.

²⁶¹ See, e.g., Perek, *supra* note 249, at 403.

²⁶² See, e.g., Leinberg, *supra* note 21, at 111-12. Current spacecraft maneuverability, however, in most instances is not very cost or mission effective. *Id.*; Felske, *supra* note 35, at 419.

²⁶³ See, e.g., Perek, *supra* note 249, at 404-05. In most instances, the commentators who argued that actual removal of debris was not economically or technologically feasible were correct. However, new developments may affect the assessment. For example, the Japanese National Space Development Agency is developing a satellite capable of removing very small debris particles. COMMUNICATION DAILY, Sept. 10, 1993, at 7.

²⁶⁴ See, e.g., BAKER, *supra* note 4, at 158.

While this is by no means an all-inclusive list, it does highlight the most important and accepted techniques of dealing with the space debris issue. As with any endeavor, each item has advantages and disadvantages. But if mankind wishes to continue to utilize outer space, the world community must take steps to limit the amount of debris it generates.

4. *Liability Provisions*

If space debris does fall within the definition of space object, then spacefaring nations will have a difficult time accounting for losses under the Liability Convention. The convention is seriously hampered by the lack of a defined standard of care or fault, and it is probably fatally flawed by difficulties associated with identifying and proving causation.²⁶⁵ This is one reason why any agreement should define space debris so that it does not fall within the meaning of space object.

If the spacefaring nations do not improve their debris identification capabilities, then any liability system which they might develop would be ineffective. If they retain the current fault based liability standard, then it will be nearly impossible to identify who is responsible for the debris. This same problem, however, would exist under an absolute liability standard.²⁶⁶ Although a party would not be required to prove the fault of the other party, it would still have to prove its identity. Until the detection and tracking capabilities improve sufficiently, the world community should transfer the risk of loss to the space community as a whole.²⁶⁷ This could be done by setting up a fund, with contributions from all launching states based on their number of launches. Any damage caused by debris could then be at least partially compensated.

²⁶⁵ See *supra* notes 98-108 and accompanying text (discussing problems with the Liability Convention).

²⁶⁶ See *supra* notes 109-14 and accompanying text (discussing absolute liability as a standard of care).

²⁶⁷ Once the tracking capabilities have sufficiently improved, an absolute liability standard would be appropriate.

VII. CONCLUSION

Space debris is a very serious threat to mankind's continued exploration of the area around our planet. While it is not as grave nor immediate a problem as some suggest, if left unchecked it will significantly increase both the cost and technical complexities associated with space exploration. The existing international legal regime is clearly inadequate to address the problem; therefore, a new international agreement is needed.

Although an international treaty could provide a solution, a multilateral approach is more realistic and flexible. Currently, the space nations are beginning to address the problem on the multinational level, and these efforts should continue and expand. The final agreement should provide guidelines on defining space debris, improving tracking and detection capabilities, improving the dissemination of information, defining an acceptable standard of care for liability, and developing preventive measures to reduce the accumulation of debris. By addressing these areas, the space nations will help ensure that future generations will be able to take advantage of opportunities in space.

